LASER APPLICATIONS IN BATTERY PRODUCTION

International Battery Seminar

Rick Davis
Head of Automotive Sales - North America

Fort Lauderdale, Florida, 3/21/2017
Electrified powertrain means challenges – and opportunities for “old“ and “new“ players in the automotive market

<table>
<thead>
<tr>
<th>fast growing market for electrified cars worldwide</th>
<th>big investments in manufacturing technologies worldwide</th>
</tr>
</thead>
<tbody>
<tr>
<td>In China's electric car boom, global automakers select different gear</td>
<td>Ford to invest $4.5 billion in electrified vehicles by 2020</td>
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<tr>
<td>India’s ambitious goal: all electric vehicles on roads by 2030</td>
<td>VW To Unleash 20 EVs By 2020 As Dieselgate Turns Into Tesla’s Tarbaby</td>
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<td></td>
<td>Forbes; 15.09.2016</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>big changes in value-added chain</th>
<th>new car manufacturers worldwide</th>
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<tr>
<td>ZF expects to adjust to early breakthrough of electro-mobility and gearbox production</td>
<td>Faraday Future</td>
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<td>E-Mobilität online; 07.09.2016</td>
<td>TESLA</td>
</tr>
<tr>
<td>The core brand has been suffering from its suspicious weakness for years. A $Bil tax scandal surrounding eleven million diesel vehicles shook the world. Electro-mobility is certainly a factor moving forward.</td>
<td>STREETSCOOTER</td>
</tr>
<tr>
<td>handelsblatt; 26.08.2016</td>
<td>Gogoro-Scooter</td>
</tr>
</tbody>
</table>
CARS – made by laser

- Lightweight Design
  - Flange reduction
  - Linear sheet metal design
  - Integrated functions
  - New materials

- Body Shop
  - Remote applications
  - Laser welding and brazing

- Cutting and Hotforming
  - Cutting hotforming parts
  - Softening
  - Inductive heating
  - 3D cutting tubes / sheets

- Electrification
  - Battery Cell/Module/Pack
  - Electric drives
  - Fuel cells
  - Electronic

- Powertrain
  - Gear welding
  - Clutches
  - Differentials
  - Shifting forks

- Interior and assembly
  - Day/Night designs
  - Marking
  - Drilling
  - Surface treatment

- Gear welding
- Clutches
- Differentials
- Shifting forks

- Car body
- Electrified powertrain
Components for electrified powertrain

Not including suspension and steering system

- cell
- module
- frame
- BMS (battery management system)
- cooling system
- electric drive
- transmission
- electronic

battery pack

electrified powertrain

powertrain
Components for electrified powertrain

- **BMS** (battery management system)
- Cooling system
- Frame
- **Cell** > **Module**
- **Battery pack**
- **Electric drive**
- **Transmission**
- **Electronic**
- **Powertrain**
- **Electrified powertrain**
Production steps – cell manufacturing

- Coating and compressing
- Slitting or Sheet Cutting
- Tap welding
- Packaging
- Filling
- Assembling

Optics

Laser source

- TruFiber
- TruMicro
- TruDisk
- TruFiber
- TruMicro
- TruDisk
- TruFiber
- TruPulse
- TruDisk
- TruFiber
- TruPulse
- TruDisk
- TruFiber
- TruMark
- TruDisk
- TruDisk
- TruMark

Source: Breyer GmbH
Source: newlong.com
# Production steps – cell manufacturing

<table>
<thead>
<tr>
<th>Production Step</th>
<th>Coating and compressing</th>
<th>Slitting or Cutting</th>
<th>Sheet Cutting</th>
<th>Tap welding</th>
<th>Packaging</th>
<th>Filling</th>
<th>Assembling</th>
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<td></td>
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<tr>
<td>Laser source</td>
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- **TruFiber**
- **TruMicro**
- **TruDisk**
- **TruPulse**
- **TruMark**

Source: Breyer GmbH

Source: newlong.com

*LASER APPLICATIONS IN BATTERY PRODUCTION, Rick Davis*
## Cutting of electrode foils

<table>
<thead>
<tr>
<th>Application</th>
<th>• cutting of electrode foil or flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>• battery electrode Cu/Al single- /two-sided coating</td>
</tr>
</tbody>
</table>
| Requirements| • burr free cutting edge  
• no particles  
• no delamination  
• no crack  
• high productivity |
| Laser       | • TruFiber  
• TruMicro  
• TruDisk |
| Customer Value | • flexibility in cutting geometry  
• cutting without dross  
• low heating zone  
• less quality control effort |
## Production steps – cell manufacturing

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<tr>
<th>Production Step</th>
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<th>Laser source</th>
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| Coating and compressing | [Optics Image](source: Breyer GmbH) | • TruFiber  
• TruMicro  
• TruDisk |
| Slitting or Sheet Cutting | [Optics Image](source: newlong.com) | • TruFiber  
• TruMicro  
• TruDisk |
| Tap welding | [Optics Image](source: Fraunhofer) | • TruFiber  
• TruPulse  
• TruDisk |
| Packaging | [Optics Image](source: newlong.com) | • TruFiber  
• TruPulse  
• TruDisk |
| Filling | [Optics Image](source: newlong.com) | • TruFiber  
• TruPulse  
• TruDisk |
| Assembling | [Optics Image](source: newlong.com) | • TruDisk  
• TruMark |

### Production Steps
- Cutting
- Slitting or Sheet Cutting
- Tap welding
- Packaging
- Filling
- Assembling

### Laser Sources
- TruFiber
- TruMicro
- TruDisk
- TruPulse

### Optics
- [TruFiber Image](source: Fraunhofer)
- [TruMicro Image](source: Fraunhofer)
- [TruDisk Image](source: Fraunhofer)
- [TruPulse Image](source: Fraunhofer)
- [TruMark Image](source: Fraunhofer)
# Tap Welding

| Application | welding of contact pins |
| Material    | Cu-Al, app. 0,3 mm |
| Requirements | joining of material combination |
|             | electrical contact |
|             | mechanical strength |
| Laser       | TruDisk |
| Customer Value | flexibility in welding geometry |
|             | no porosity, no cracks |
|             | clean working process |
|             | little space requirements |
|             | no mechanical stress |
# Production steps – cell manufacturing

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Source: Breyer GmbH
Source: newlong.com

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**Laser applications in battery production**

TruFiber, TruMicro, TruDisk, TruPulse, TruMark.
## Welding battery housing

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<th>Application</th>
<th>• welding of battery housing</th>
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<tbody>
<tr>
<td>Material</td>
<td>• Al; 0.6 - 1 mm</td>
</tr>
<tr>
<td>Requirements</td>
<td>• gas-tight sealing</td>
</tr>
<tr>
<td></td>
<td>• no splatter</td>
</tr>
<tr>
<td>Laser</td>
<td>• TruDisk</td>
</tr>
<tr>
<td>Scanner</td>
<td>• PFO (Programmable Focus Optics)</td>
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<tr>
<td>Customer Value</td>
<td>• high productivity</td>
</tr>
<tr>
<td></td>
<td>• low heat input</td>
</tr>
<tr>
<td></td>
<td>• no distortion</td>
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<td>• no mechanical load</td>
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Laser applications in E-Mobility

Laser applications for e-mobility
Production steps – cell manufacturing

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<td>Assembling</td>
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<td>• TruMark</td>
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Cutting

Welding

Welding, Marking

Source: Breyer GmbH
Source: newlong.com
**Welding of bus bar**

<table>
<thead>
<tr>
<th>Application</th>
<th>• welding of bus bar</th>
</tr>
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</table>
| Material        | • Cu-Cu; 0,3 mm – 1 mm  
• Al-Al; 0,3 mm – 1 mm |
| Requirements    | • electrical contact  
• mechanical strength |
| Laser           | • TruDisk             |
| Scanner         | • PFO (Programmable Focus Optics) |
| Customer Value  | • flexibility in cutting geometry  
• no splittings  
• no splatter |
Welding of electronic parts / welding copper with green laser

Uniformity of spot welds on different surface conditions @ 515 nm

- Weld quality does not depend on surface quality of copper
- High accuracy in weld depth – no influence on parts beneath weld area
- Spatter free welds – especially important for electronic parts

Laser is the right tool for welding electric parts (e.g. battery, electric drives, electronic devices) with high efficiency and high quality
Green pulsed laser system

Peak Power 4 kW; average power 750 W; \( \lambda \) 515 nm
## Marking of battery cell

| Application          | • Marking of Al and Cu  
|                      | • Text, Bar-Code, Datamatrix-Code |
| Material             | • Cu, Al; 0.2 – 0.3 mm |
| Requirements         | • Enduring readability of the code  
|                      | • High flexibility regarding content, e.g. serial number  
|                      | • Low influence of material |
| Laser                | • TruMark |
| Scanner              | • App. 1 min for data matrix code |
| Customer Value       | • Flexibility of marking geometry  
|                      | • Flexibility of material |
CARS – made by laser

Laser Tools by TRUMPF

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  - Flange reduction
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  - Fuel cells
  - Electronic
YOUR CONTACT

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